



"A PROSPECTIVE STUDY TO CLINICALLY EVALUATE THE EFFECTIVENESS OF PERCUTANEOUS TENOTOMY OF ACHILLES TENDON USING 16-GAUGE NEEDLE IN IDIOPATHIC CLUBFOOT"

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ABSTRACT

Introduction: Congenital Talipes Equinovarus (CTEV), commonly known as clubfoot, is a congenital musculoskeletal disorder characterized by deformities such as cavus, adduction, varus and equinus. Affecting approximately 1 in 1000 births worldwide, clubfoot often hinders walking, running, and other physical activities. The Ponseti method is a widely accepted treatment method which involves serial manipulation and casting, aiming to achieve a functional, pain-free, plantigrade foot with good mobility. Despite the success of this method, residual equinus deformity often persists, necessitating an Achilles tenotomy. This study aims to evaluate the clinical outcomes and safety of using an 16-gauge needle for this procedure, assessing its effectiveness in correcting clubfoot deformities. **Methodology:** This prospective clinical study was conducted on 45 patients (76 feet) diagnosed with idiopathic clubfoot. The percutaneous Achilles tenotomy using an 16-gauge needle was performed under general anaesthesia. Patients were assessed using the Pirani score, passive dorsiflexion angle at the ankle, and foot bimalleolar angle. Follow-ups were conducted at 3 weeks, 2 months, 6 months, and 1-year post-procedure. Ultrasonography (USG) was employed to monitor tendon healing and detect any complications. Data were analysed to evaluate the improvement in foot alignment and function from the baseline preoperative data. **Results:** The study demonstrated significant improvements in clinical outcomes posttenotomy. The mean age of patients at the time of the procedure was 7.3 months, with the majority being male and having bilateral involvement. The mean Pirani score decreased subsequently from (2.114 ± 0.4) to 0 at the end of one year follow-up. There was decrease in the passive angle of dorsiflexion at ankle between pre-op and at 1 year of follow-up, mean passive dorsiflexion angle at ankle at pre-op was $(128.74^\circ \pm 12.04)$, while 4th follow-up $(76.21^\circ \pm 2.15)$. The mean foot bimalleolar angle increased from 70.09° pre-operatively to 81.74° at the oneyear follow-up, indicating substantial correction of the deformity. The procedure effectively addressed the equinus deformity, with most patients achieving a plantigrade foot. Complications were minimal, with no significant neurovascular issues or infections reported. However, there were instances of abnormal bleeding and a few cases of relapse requiring further intervention. Overall, the use of an 16-gauge needle for the tenotomy was associated with favourable outcomes and a low complication rate. **Conclusion:** The study concludes that percutaneous Achilles tenotomy using an 16-gauge needle is an effective and safe technique for treating idiopathic clubfoot. The procedure resulted in significant improvements in foot alignment and function, with minimal complications. These findings support the adoption of this technique as a standard practice in the management of clubfoot. The use of the 16-gauge needle offers a minimally invasive, efficient, and reliable method for achieving the desired clinical outcomes in clubfoot treatment.

KEYWORDS : Clubfoot, percutaneous, tendoachilles, tenotomy, 18G needle

INTRODUCTION:-

The Congenital Talipes Equinovarus (CTEV), mainly called clubfoot, is a congenital musculoskeletal disorder affecting the lower limb – it has an incidence of 1 in 1000 births worldwide. This abnormal foot called Clubfoot is manifested by cavus (high arched foot), equinus (plantarflexion), adduction (medial deviation) and varus (inversion). In general, clubfoot complicate either walking, running, or various kinds of physical exercise. The knowledge of the etiology, clinical features, and diagnostic procedures along with treatment options is humbly needed for effective management and favourable patient outcomes.⁽¹⁾

Ponseti method of serial manipulation and casting comes closest to of achieving the ultimate goal of treatment i.e. to achieve a functional, pain-free, plantigrade foot with good mobility and without calluses overcoming the issues of extensive scarring, residual pain and inadequate correction as seen with the other procedures such as bandages by Hippocrates, plaster casts by Kite and surgical treatment by Turco.⁽²⁾

After the final manipulation in management of clubfoot, there is some residual equinus deformity at ankle which persists. In a few cases the equinus can be corrected by manipulation, but in 80-85% the Achilles tendon is too tight and a tenotomy is needed. Achilles Tenotomy is also called as percutaneous tenotomy, a tendo-Achilles lengthening tenotomy, or a heel cord lengthening/tenotomy.

Tendoachilles tenotomy, a crucial procedure in correcting congenital talipes equinovarus (CTEV), can be performed using various methods:

Percutaneous Tenotomy⁽²⁾⁽³⁾⁽⁴⁾⁽⁵⁾⁽⁶⁾:

This minimally invasive technique involves making a small incision in the skin overlying the Achilles tendon. A sharp instrument, such as a blade or a needle, is then used to cut the tendon. This method is often performed under local anaesthesia and is associated with quicker recovery times. First it was done by Delpech in 1823, where he performed subcutaneous tenotomy of the Achilles tendon in two patients with acquired talipes equinovarus. Stromeyer and Little continued research on the procedure for acquired talipes equinovarus. But Rogers in 1834 and Dickson in 1835 were the first to perform subcutaneous tenotomy for clubfoot in the United States. In 2004 Barbara Minkowitz et al introduced a new technique for percutaneous Achilles tendon tenotomy, using a large-gauge precision-glide needle. The needle initially used was an 18-gauge needle but then 16-gauge needle was used due to its stiffness.

Open Tenotomy⁽⁷⁾⁽⁸⁾:

In this approach, a larger incision is made directly over the Achilles tendon, allowing direct visualization. Surgical instruments are then used to cut the tendon. Open tenotomy was 1st performed by Ali Dogan et al in 2008 by a mini-open incision. It may be preferred in cases where there are anatomical variations or if additional procedures are needed, and it can provide more precise control over the tendon release and prevent complications⁽⁹⁾.

The tenotomy corrects the residual equinus deformity. It is a complete cut through of the Achilles tendon, not a tendon lengthening. It creates a very small incision - it is known as a percutaneous ("through the skin") tenotomy. It is necessary because although tissues yield to gentle stretch, collagen of

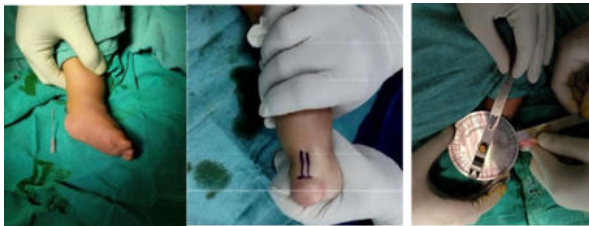
the Achilles tendon is more restrictive than the joint capsule and ligaments and does not respond to stretching as predictably. In infants the tendon heals sufficiently in 3 weeks.⁽¹⁰⁾⁽¹¹⁾

MATERIAL AND METHODS:-

The study was a prospective study to clinically evaluate the effectiveness of percutaneous tenotomy of achilles tendon using 18-gauge needle in idiopathic clubfoot" conducted at Department of Orthopaedics, NSCB Medical College and Hospital after getting approval from the ethical committee during the time period of 15th March 2023 to 30th June 2025. A total of 45 patients (76 feet) were included in the study after obtaining proper consent. Children age < 5 years with unilateral/bilateral idiopathic clubfoot were included while children with neurogenic clubfoot, myelomeningocele, distal arthrogryposis and acquired clubfoot were excluded from the study. The child that presented to our CTEV clinic was assessed and Pirani score was calculated. Serial Casting was done at the interval of 1 week and regularly followed up. When residual equinus was the only deformity left to be corrected the patient was admitted for percutaneous Tendoachilles needle tenotomy. Pre-anaesthetic fitness was obtained for percutaneous needle tenotomy under general anaesthesia. The angle of passive dorsiflexion around the ankle before the procedure was recorded clinically and video recorded and the foot bimalleolar angle from podogram was plotted.

Procedure:

After full effect of anesthesia painting and draping was done. The child was positioned supine and the knee was kept in 90 degrees of flexion and foot was held in forced plantar flexion and tendoachilles is palpated and marked.⁽¹²⁾ 16G needle (Dispo-van) is inserted from the medial to lateral aspect in the substance of the tendoachilles. Using the beveled end of the needle and swinging motion the tendon is cut and a snap is felt. The cut tendon is clinically evaluated by the increase in passive dorsiflexion. The increase in dorsiflexion is clinically measured and video recorded.



Tincture benzoine is applied at the site. POP cast in overcorrection is applied for 3 weeks with tags (usually the plastic cover of the used cast cut into small pieces) placed in end of each layer. The tags help the for easy identification of ends of cast thus aiding in easy removal. The capillary refill time was checked before shifting the patient to ward after observation.



POST-OP Protocol:-

After 3 weeks (i.e. on 1st follow-up) cast is removed. Pirani Score, passive dorsiflexion foot-bimalleolar angle using podogram is evaluated clinically and recorded. USG is done to assess the healing at the 1st follow up at 3 weeks. Equipment used: ALPINION E-CUBE-47 using high frequency linear probe (7.5 – 10 MHz). Steenbeck's Brace is then given to the child to maintain correction and the parents are explained about the necessity and the bracing protocol. The child is then

followed up at 2 months, 6 months and 1 year respectively. Pirani Score, passive dorsiflexion at the ankle, foot-bimalleolar angle using podogram is evaluated clinically and recorded. The braces are checked for size and replaced (if necessary). Walking shoes are custom made when child starts walking.

CASE SERIES

Case 1: 3 months female with bilateral clubfoot



1st CAST CLINICAL IMAGES



2ND CAST CLINICAL IMAGES



3RD CAST CLINICAL IMAGES



PRE-TENOTOMY CLINICAL IMAGES



INTRA-OPERATIVE CLINICAL IMAGES

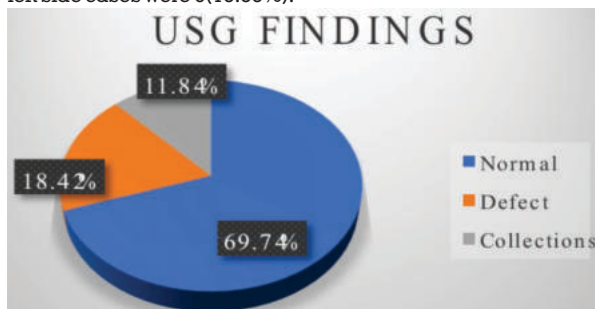


1ST FOLLOWUP (at 3 weeks)

2ND FOLLOW-UP (at 2 months)3RD FOLLOWUP (at 6 months)4TH FOLLOWUP (at 1 year)

RESULTS:-

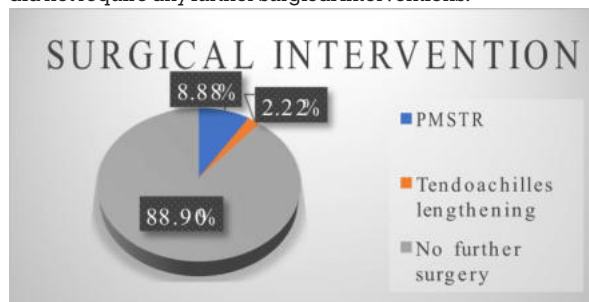
In this study it was observed that the mean age at which tenotomy was done was found to be (7.3 ± 2.76) months. With majority belonging to age group of 6-11 months i.e. 28(62.22%), followed by age group ≤ 5 months i.e. 15(33.33%) and least belonged to ≥ 12 months i.e. 2(4.44%). It was noted that male subjects were predominant i.e. 32(71.11%) while the females were 13(28.89%). Majority of the cases were bilateral case i.e. 31(68.89%), 8 cases (17.78%) were of right side and left side cases were 6(13.33%).



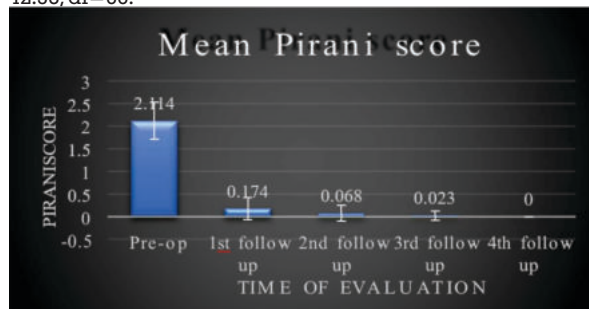
All 76 feet were evaluated on 1st follow-up at 3 weeks by USG, which revealed that 14 feet i.e. (18.42%) showed defect in the tendoachilles, 9 feet i.e. (11.84%) had collections noted around the tendon while rest feet showed normal study on scan. The abnormalities detected at 1st follow-up (at 3 weeks) resolved at 2nd follow-up (at 2 months).

The present study revealed that mostly the children 33 i.e. (73.34%) were born by normal vaginal delivery while rest 12 i.e. (26.66%) were born by C-section.

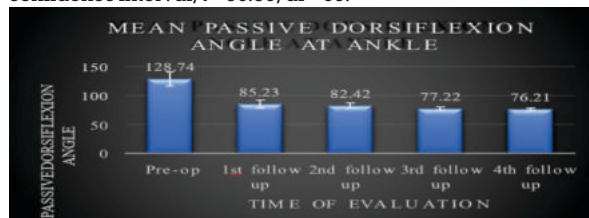
It was seen that 13 patients i.e. (28.88%) required subsequent casting in over-correction for an additional 1 week on their 1st follow up i.e. at 3 weeks while majority 32 patients i.e. (71.11%) received Steenbeek brace. It was observed that 4 patients i.e. (8.88%) patients did not maintain correction and required PMSTR (Postero-medial soft tissue release) and 1 patient i.e. (2.22%) required unilateral Tendoachilles lengthening while majority of patients 40 i.e. (88.90%) maintained correction and did not require any further surgical interventions.



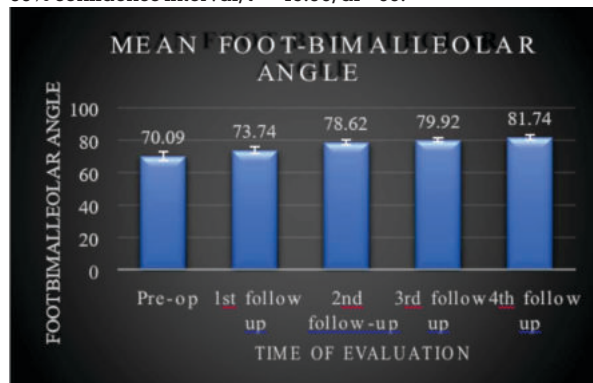
The Pirani score was recorded at 1st, 2nd, 3rd and 4th follow-up i.e. at 3 weeks, 2 months, 6 months and 1 year respectively and it was observed that the mean Pirani score at pre-op was (2.114 ± 0.4) , while on 1st follow-up it was (0.174 ± 0.24) , on 2nd follow-up (0.068 ± 0.173) 3rd follow-up were (0.023 ± 0.104) and on 4th follow-up was 0. The Pirani score decreased on subsequent follow-ups between pre-op and at 1 year of follow-up with mean (2.11 ± 0.4) ($p < 0.05$), 95% confidence interval, $t = 42.93$, $df = 66$.



The angle of passive dorsiflexion around the ankle was recorded pre-op and post op on at 1st, 2nd, 3rd and 4th follow-up i.e. at 3 weeks, 2 months, 6 months and 1 year respectively and it was observed that the mean passive dorsiflexion angle at ankle at pre-op was $(128.74^\circ \pm 12.04)$, while on 1st follow-up it was $(85.23^\circ \pm 6.57)$, and on 2nd follow-up $(82.42^\circ \pm 2.21)$ and subsequently on 3rd follow-up $(77.22^\circ \pm 3.21)$ and on 4th follow-up $(76.21^\circ \pm 2.15)$. There was decrease in the passive angle of dorsiflexion at ankle between preop and at 1 year of follow-up with mean (52.53 ± 11.57) ($p < 0.05$), 95% confidence interval, $t = 36.90$, $df = 65$.



The foot bimalleolar angle was recorded pre-op and post op on 1st, 2nd, 3rd and 4th follow-up i.e. at 3 weeks, 2 months, 6 months and 1 year respectively and it was observed that the mean foot bimalleolar angle at pre-op was $(70.09^\circ \pm 2.70)$, while on 1st follow-up the mean foot bimalleolar angle recorded was $(73.74^\circ \pm 2.00)$, on 2nd follow-up $(78.62^\circ \pm 1.63)$, on 3rd follow-up $(79.92^\circ \pm 1.13)$ and on 4th follow-up $(81.74^\circ \pm 1.58)$. There was subsequent increase in mean foot bimalleolar angle between pre-op and at 1 year of follow-up with mean (-11.65 ± 1.93) , 95% confidence interval, $t = -48.96$, $df = 65$.



DISCUSSION:-

Ponseti et al had originally used the ophthalmic scalpel for the tendoachilles tenotomy while later other surgeons used the no. 15 blade for tenotomy which produced excellent results, though neurovascular complications were also reported due to the vascular anatomical variations by Burghardt RD et al⁽⁹⁾. Later mini-open techniques were used by Rhett MacNeille et al⁽⁷⁾ and Ali Dogan et al⁽⁸⁾ to prevent complications while Botulinum toxins was used by Christine M Alvarez⁽¹³⁾ et al as non-operative management. Keratome was used by Shobhit Goyal et al⁽¹⁴⁾ as it had advantages over the blade in reducing complications and providing similar results. Then Barbara Minkowitz et al⁽⁴⁾ used a large bore needle for sectioning of the tendoachilles and now many surgeons are following suit.

We conducted a similar study which aimed to prove the effectiveness of 16G needle in tendoachilles tenotomy in idiopathic clubfoot and assess the healing of the tendon using USG. In the study a total of 45 patients were included who had undergone initial serial casting to correct midfoot cavus, forefoot adduction, hindfoot varus and the residual equinus was treated using needle tenotomy of the tendoachilles. (15) where the majority of children belonged to age group 6-11 month (37%). While similar studies by Ritesh Arvind Bobby et al⁽¹⁶⁾, Daniel Augusto Marahno et al⁽³⁾, Shreya Alva et al⁽⁶⁾ (17), and Benjamin et al had a mean age of tenotomy at 4.1 months, 4.2 months, 4 months and 4.5 months respectively.

Sex:

In our study it was noted that male subjects were predominant i.e. 32(71.11%) while the females were 13(28.89%). Studies by Ritesh Arvind Bobby et al⁽¹⁶⁾, Ripudaman Sharma et al (19) (15) (17)

Benjamin et al, showed similar finding with majority of the cases being males. While contrasting results were found where nearly equal number of males and females were found in studies by Shreya Alva et al⁽⁶⁾ and Fashmi Subhi Alghazawi et al⁽⁵⁾.

Side Involvement:

This study revealed that majority of subjects had bilateral involvement i.e. 31(68.89%), 8 cases (17.78%) were of right side and left side cases were 6(13.33%). Similar results were found in studies by Shreya Alva et al⁽⁶⁾, Ripudaman Sharma et al⁽¹⁹⁾ and Mc Neil et al⁽⁷⁾ where majority were bilateral cases of 88%, 85% and 69% respectively. While dissimilar results were found in study by Stephen A Prada et al⁽¹³⁾ showed majority

cases were of right foot involvement 47% while bilateral involvement was only 33%. In another study by Angela Evans et al⁽²⁰⁾ revealed 45% cases to have unilateral involvement and 55% showing bilateral involvement nearly similar distribution of side involvement.

USG findings: In the present study all 76 feet were evaluated on 1st follow-up at 3 weeks by USG, which revealed that 14 feet i.e. (18.42%) showed defect in the tendoachilles, 9 feet i.e. (11.84%) had collections noted around the tendon while rest feet showed normal study on scan.

The abnormalities detected at 1st follow-up (at 3 weeks) resolved at 2nd follow-up (at 2 months). In a similar study by Anil Agarwal et al⁽²¹⁾ showed disorganized and hypoechoic tendons at 3 weeks while near normal tendon were observed between 6-12 months. While a study by Hisateru Nikki et al⁽²²⁾ revealed 43% patients had no gap separation and by 3-4 weeks continuity was noted in all cases. The tendoachilles were comparable to as of the normal by the end of 2 years. Though there was no comment regarding the presence of collections in any of the studies. Similarly, a study conducted using MRI as a tool for regeneration of tendoachilles by Maye Kao et al⁽²³⁾ revealed that 9 out of 11 i.e. 81% had continuity in tendon at 3 weeks while at 6 weeks all 11 patients had continuity. Another study by Raghav Saini et al⁽²⁴⁾ reported that there were signs of regeneration till 6 weeks while there was complete resolution by 6 months.

Cast at 1 follow-up and further surgical intervention: In the study it was observed that 13 patients i.e. (28.88%) required subsequent casting in over-correction for an additional 1 week on their 1st follow up i.e. at 3 weeks while majority 32 patients i.e. (71.11%) received Steenbeek brace. In a study by Okwesili C Ikechukwu et al⁽²⁵⁾ compared blade and needle tenotomy and had 3 patients of relapse (2 i.e. 4.7% in blade group and 1 i.e. 2.3% in needle group) resolved with further manipulation and casting. In our study out of the 13 patients, 4 required subsequent PMSTR later and 1 patient required unilateral TA lengthening. Thus, post tenotomy cast application for another 1 week reduced the risk of relapse in about 69% cases where optimum correction was not obtained post tenotomy.

It was observed that 4 patients i.e. (8.88%) patients did not maintain correction and required PMSTR (Postero-medial soft tissue release) and 1 patient i.e. (2.22%) required unilateral Tendoachilles lengthening while majority of patients 40 i.e. (88.90%) maintained correction and did not require any further surgical interventions. In study by Raghav Saini et al⁽²⁴⁾ 1 patient required tendoachilles lengthening while study by Ehud Lebel et al⁽²⁶⁾ 7 i.e. 12% babies required repeat tenotomy. 13.33% cases of relapse were noted in study by Fashmi Subhi Alghazawi et al⁽⁵⁾. 1 open tendoachilles tenotomy was done in a study conducted by Ritesh Arvind Pandey et al⁽¹⁶⁾. In our study the children needing PMSTR were usually of higher age group mostly > 11 months, while 1 patient was of age 6 months.

Pirani Scoring:

The Pirani score was recorded at 1st, 2nd, 3rd and 4th follow-up i.e. at 3 weeks, 2 months, 6 months and 1 year respectively and it was observed that the mean Pirani score at preop was (2.114 ± 0.4) , while on 1st follow-up the mean Pirani score recorded was (0.174 ± 0.24) , on 2nd follow-up (0.068 ± 0.173) 3rd follow-up were (0.023 ± 0.104) and on 4th follow-up was 0. While in similar study by Ripudaman Sharma et al⁽¹⁸⁾ had a mean Pirani score before tenotomy 1.73 while post tenotomy was 0.16 and at by the end of 1 year it was 0.14. Another study by Ritesh Arvind Pandey et al⁽¹⁶⁾ reported post tenotomy Pirani score 0.07 at the end of 6 months. A study conducted by Benjamin et al⁽¹⁷⁾ had a pre-tenotomy Pirani score of 1.5 and post tenotomy score of 0.5 after 1 year of follow-up. Choubey et

al⁽²⁷⁾ compared the findings between and blade and needle where it was observed post tenotomy Pirani score of 0.26 for blade and 0.31 for needle. Similar study by Fahmi Subhi Alghazawi et al⁽⁵⁾ reported Pirani score of (1.08 ± 0.3) , (0.91 ± 0.32) at the end of 3 months and 6 months respectively post tenotomy. A study by Mohit Dhirgr et al⁽²⁸⁾ had a mean pre tenotomy score of (1.2 ± 0.7) while post tenotomy score was 0 at the end of 6 months. In another study by A Vidyarthi et al⁽¹⁵⁾ the mean Pirani score reduced to 0.4 post tenotomy in relapsed clubfoot cases.

Passive dorsiflexion angle at ankle: In our study it was seen that the mean passive dorsiflexion angle at ankle at pre-op was $(128.74^\circ \pm 12.04)$, while on 1st follow-up $(85.23^\circ \pm 6.57)$, and on 2nd follow-up $(82.42^\circ \pm 2.21)$ and subsequently on 3rd follow-up $(77.22^\circ \pm 3.21)$ and 4th follow-up $(76.21^\circ \pm 2.15)$. There was decrease in dorsiflexion post tenotomy in follow-up. No studies have compared the passive decrease in dorsiflexion post tenotomy in follow-ups though, studies by Silvia Richetta et al⁽²⁹⁾, Benjamin et al⁽¹⁷⁾, Dogan et al⁽⁸⁾, Hazem M ElTayeby et al⁽³⁰⁾ and Raghav Saini et al⁽²⁴⁾ by $>10-20^\circ$, $>15^\circ$, $>20-30^\circ$, $>30^\circ$ and $>15^\circ$ respectively post tenotomy. Alvarez et al⁽¹³⁾ used Botulinum Toxin and reported an increase of 20- 35° of dorsiflexion.

Foot bimalleolar angle: It was observed that the mean foot bimalleolar angle at pre-op was $(70.09^\circ \pm 2.70)$, while on 1st follow-up the mean foot bimalleolar angle recorded was $(73.74^\circ \pm 2.00)$, on 2nd follow-up $(78.62^\circ \pm 1.63)$, on 3rd follow-up $(79.92^\circ \pm 1.13)$ and on 4th follow-up $(81.74^\circ \pm 1.58)$. The results showed an increase in the angle with serial follow-up and approached close to the normal i.e. 82.5° as reported by A.K. Jain et al⁽³¹⁾. Similar study conducted by Abhay Shankar Dubey et al⁽³²⁾ reported pre-plaster, pre tenotomy and before bracing foot bimalleolar angles of 67.62° , 76.08° and 79.12° respectively which were congruent to our study. Similar findings were seen in study by Bajaj V et al⁽³³⁾ that had foot bimalleolar angles of $(66.55^\circ \pm 2.06)$ at beginning of casting, $(70.8^\circ \pm 3.15)$ after 4 weeks and $(79.23^\circ \pm 1.36)$ at the completion of treatment. Another study conducted by A Vidyarthi et al⁽¹⁵⁾ in relapsed and neglected clubfoot also reported increase in foot bimalleolar angle over the course of treatment.

CONCLUSION:-

In our study we had aimed to prove the effectiveness of 16G needle for tendoachilles tenotomy. There was serial improvement in the Pirani score, decrease in passive angle of dorsiflexion at angle and increase in the foot bimalleolar angle over 1 year of followup. There was no defect in the continuity of tendoachilles after 2 months of tenotomy. This method of percutaneous tenotomy was found to be effective and safe to achieve a supple, painless and plantigrade foot. No complications of pseudo-aneurysm, blisters, pressure sore, infections, neurovascular compromise or slippage of cast were seen. However, there were 2 case of abnormal bleeding which stopped by applying pressure for few minutes. The blood loss was less than 1 ml. Though 5 cases of relapse were noted and required further surgery as they did not respond to manipulation and casting post tenotomy.

All the cases were done under general anesthesia in OT setting which provided a protective environment and also allowed pain management for children during the procedure and also provided the operating surgeon the peace of performing the procedure safely, minimizing the risk of incomplete tenotomy and the necessary modalities for tackling any intra-operative complications if it occurred.

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